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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/499,037	02/07/2000	Kazuhiro Aihara	49657-551	9656

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EXAMINER

MONDT, JOHANNES P

ART UNIT	PAPER NUMBER
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2826

DATE MAILED: 12/12/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/499,037

Applicant(s)

AIHARA ET AL.

Examiner

Johannes P Mondt

Art Unit

2826

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 18 October 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-12 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 4-6 is/are allowed.
- 6) ☒ Claim(s) 1-3 and 7-12 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 14.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Information Disclosure Statement

The examiner has considered the Korean language patents-laid-open and the accompanying examination report listed in Information Disclosure Statement of Paper No. 14 filed 06/21/2002 to the extent possible, given his lack of sufficient knowledge of the Korean language.

Response to Amendment

Amendment C filed 10/18/2002 and entered as Paper No. 15 forms the basis of this office action. In Amendment C Applicant has substantially amended claims 1, 2 and claims dependent upon claims 1 and 2, and added new claims 7-12. Comments on Remarks by Applicant in said Amendment C are included below under "Response to Arguments".

Response to Arguments

Applicant's arguments filed 10/18/2002 have been fully considered but they are not persuasive with regard to claims 1, 2 and 3. In particular, the tantalum nitride film of Applicant inherently has a work function of 5.41 eV. See Liang et al (6,130,123). With regard to claim 3, Applicant has presented an argument with regard to the difference between the tantalum oxide as disclosed in the specification and the perovskite type tantalum oxide taught by Kang. However, the term "tantalum oxide" has plain and ordinary meaning and does apply to the tantalum oxide found in the prior art as offered by Kang. Ample arguments for motivation and combinability of the relevant teaching by Drynan have been presented in the rejection of claim 3. Applicant does not address, in

his traverse, why said arguments are incorrect. With regard to the new claims, there is no support in the specification for a tantalum nitride film with a work function of "up to 5.41 eV", and hence claims 7 and 10 must be rejected under U.S.C. 112, first paragraph.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. ***Claims 7 and 10*** are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. In particular, the specification only discloses tantalum nitride films with a work function of 5.41 eV, not tantalum nitride films with a work function up to 5.41 eV; see Applicant's disclosure.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

1. **Claims 1 and 8-9** are rejected under 35 U.S.C. 102(e) as being anticipated by Choi et al (6,168,991 B1). Choi et al teach a semiconductor device, comprising: a contact plug including a tungsten film 14 (cf. column 4, lines 3-10) in an upper portion of the contact plug, formed on a semiconductor substrate (dielectric layer 19 (cf. column 3, lines 43-44) is formed over the field effect transistor which is inherently formed on a semiconductor substrate, in this case inter alia through HDP (cf. column 3, lines 52-57) which is understood to involve formation on a semiconductor wafer); a storage electrode 20 (cf. column 4, lines 38-56) including a tantalum nitride film serving as a barrier against copper migration into the capacitor dielectric film 22, said tantalum nitride film being formed on and contacting an upper surface of said tungsten film; a capacitor dielectric film 22 (cf. column 4, lines 57-67) including a tantalum oxide film (cf. column 4, line 67) formed on and contacting an upper surface of said tantalum nitride film; a cell plate electrode 26 (cf. column 5, lines 20-33) including a tantalum nitride film (cf. abstract, sixth sentence) formed on and contacting an upper surface of said tantalum oxide film. Values for the work function in excess of 4.95 eV are inherent for tantalum nitride electrode films (see Liang et al (6,130,123), column 5, lines 26-30).

With regard to claims 8-9: the work function of the tantalum nitride film of claim 1 as anticipated by Choi is 5.41 eV.

Claims 2 and 11-12 are rejected under 35 U.S.C. 102(e) as being anticipated by Choi et al (6,168,991 B1). Please be referred to Figure 8. Choi et al teach a semiconductor device (cf. Field of Invention, column 1, lines 16-20), comprising: a storage electrode 20 (cf. column 4, lines 38-56) including a first tantalum nitride film (cf. column 4, line 39) formed over a semiconductor substrate (dielectric layer 10 (cf. column 3, lines 43-44) is formed over the field effect transistor which is inherently formed on a semiconductor substrate, in this case through HDP (cf. column 3, lines 52-57) which is understood to involve formation on a semiconductor wafer); a capacitor dielectric film 22 (cf. column 4, lines 57-67) including a tantalum oxide film (cf. column 4, lines 65-67) formed on and contacting an upper surface of said first tantalum nitride film; a cell plate electrode 26 (cf. column 5, lines 20-33) including a second tantalum nitride film (cf. abstract, sixth sentence) formed on and contacting an upper surface of said tantalum oxide film; and a copper film 28/30 (cf. column 5, lines 60-65 and column 6, lines 18-21) formed on and contacting an upper surface of said second tantalum film. Values for the work function in excess of 4.95 eV are inherent for tantalum nitride electrode films (see Liang et al (6,130,123), column 5, lines 26-30). See Liang et al (6,130,123), column 5, lines 26-30). In conclusion, Choi et al anticipate claim 2.

With regard to claims 11-12: the work function of the tantalum nitride film of claim 1 as anticipated by Choi is 5.41 eV.

1. **Claim 3** is rejected under 35 U.S.C. 103(a) as being unpatentable over Kang (6,211,005 B1) in view of Drynan et al (ISBN: 0-7803-4774-9). Please be referred to Figure 7. Kang teaches a semiconductor device (cf. title, abstract, and column 7, line 23), comprising:

a semiconductor substrate 40 (cf. column 7, line 23) ;

a contact plug 52 (cf. column 6, lines 13-15) formed on the semiconductor substrate;

a storage electrode 54 (cf. column 6, lines 16-32) including a first indium oxide film (cf. column 6, lines 27-32) on and contacting an upper surface of said contact plug;

a capacitor dielectric film 56 (cf. column 6, lines 16-36) including a tantalum oxide film 56 (cf. column 6, lines 32-36), particularly an perovskite oxide such as strontium bismuth tantalum oxide (cf. column 6, line 36), said capacitor dielectric film 56 being formed on and contacting an upper surface of said first indium oxide film 54; and

a cell plate electrode 58 (cf. column 6, lines 16-26) including a second indium oxide film (cf. column 6, lines 28-32) formed on and contacting an upper surface of said tantalum oxide film 56.

Kang does not necessarily teach the contact plug to include tungsten. However, the selection of tungsten as the material for contact plugs in DRAM semiconductor capacitor structures has long been known to be advantageous because (a) of the low resistivity of tungsten and (b) favorable thermal budget, while (c) tungsten can be selected for all interconnect structures, thus reducing manufacturing costs by reducing

processing steps: all these three advantages are taught by Drynan et al (cf. title, abstract and introduction, "Shared W for DRAM-Logic Convergence", page 31.6.1, lines 1-13 in the second column).

Motivation for low resistivity of the interconnects (as opposed to the resistivity of the peripheral region) is ubiquitous to all DRAM capacitors including and particularly in the invention by Kang as resistivity impedes response time while reduction of the dimensions as aimed for by Kang increases the importance of the possibility to avoid inter-metal junctions, as would exist if a selection other than tungsten for said contact plugs were to be combined with the standard selection of tungsten for the major material for interconnects. Also, processing step reduction would reduce the cost of making the device invented by Kang. The inventions can be combined, because the making of W contact plugs is standard in the art (see for instance Wolf et al, page 210). Therefore, success in implementing the combination can be reasonably expected.

Allowable Subject Matter

2. **Claim 4-6** are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.
3. The following is a statement of reasons for the indication of allowable subject matter:

Claim 4 contains allowable subject matter, because the device as defined by claim 3 and as rendered unpatentable over Kang in view of Drynan et al with

the storage electrode further including a tantalum nitride film formed beneath and contacting an upper surface of the tantalum oxide film has not been found in the prior art while specific teaching showing why such inclusion would be obvious has not been found in the prior art either. Although tantalum nitride films are known as barrier layers, especially with regard to copper, their role with regard to tungsten is less evident because tungsten itself is a good barrier material.

Claim 5 contains allowable subject matter, because the device as defined by claim 3 and as rendered unpatentable over Kang in view of Drynan et al with the further inclusion of a copper film formed on and contacting said second indium oxide film has not been found in the prior art while specific teaching showing why such inclusion would be obvious has not been found in the prior art either.

Claim 6 contains allowable subject matter, at least because the device as defined by claim 5 contains allowable subject matter, while the further limitation of claim 6 has not been found in the prior art.

Conclusion

4. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P Mondt whose telephone number is 703-306-0531. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J Flynn can be reached on 703-308-6601. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

JPM

December 10, 2002


NATHAN J. FLYNN
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